Flow Dichroism in Critical Fluids

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On approach of the gas-liquid critical point, interactions become very long ranged. These long ranged correlations are responsible for so-called critical phenomena. Due to these long ranged spatial correlations and critical slowing down, the microstructural order near the gas-liquid critical point is extremely sensitive to shear flow. For very small shear rates (in reciprocal seconds) the turbidity can go down enormously, changing the sample from being white to almost transparent. This change in turbidity is directly related to the change of microstructural order due to the applied shear field. Measurement of the shear rate dependence of the turbidity at various distances from the critical point can be used to test theoretical predictions of microstructural order under shear flow.

Due to the anisotropy of the microstructure under shear flow, besides a change of the turbidity, dichroism is induced by the shear flow, that is, the turbidity will depend on the polarisation state of the incident light. Measurement of shear induced dichroism is a sensitive test for the anisotropic nature of the theoretically predicted microstructure under shear flow.

After a theoretical overview, experimental data on shear induced dichroism as a function of shear rate and the distance from the critical point are presented. The system used, is a colloidal hard-sphere suspension with polymer added to induce attractions, giving rise to a gas-liquid critical point. Within the mean-field region, comparison with theoretical scaling predictions is made. Beyond the mean-field region we observe a completely different behaviour as compared to the mean-field behaviour, for which no theoretical predictions exist.